Sediment provenance indicated by magnetic susceptibility and inorganic geochemistry in the Baker-Martínez fjord system (Chile, 48°S)

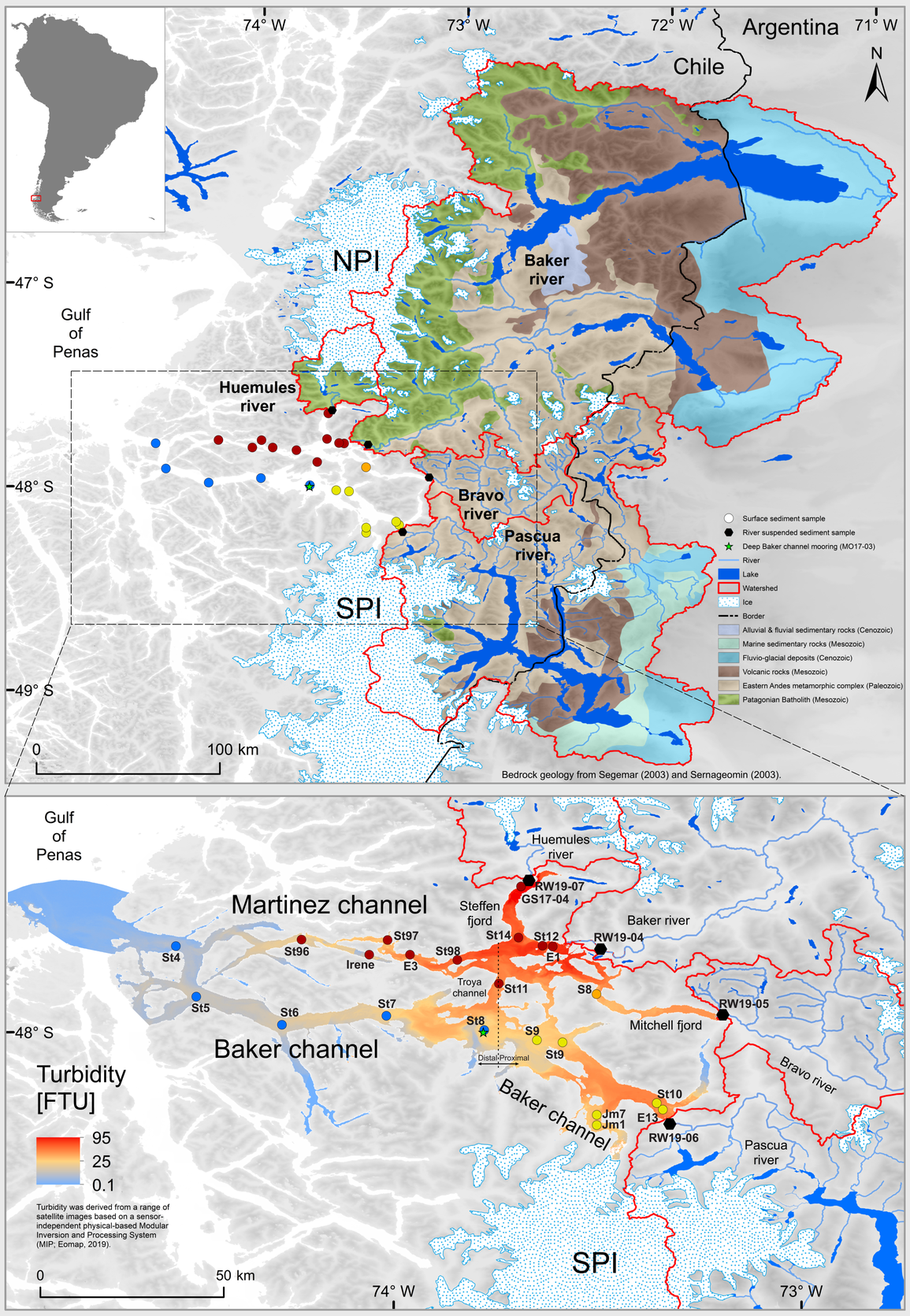
Matthias Troch[1], Sébastien Bertrand[1], Benjamin Amann[1], Dawei Liu[1], Juan A. Placencia[2], Humberto E. Gonzalez[3], Carina B. Lange[3,4]

[1] Renard Centre of Marine Geology, Department of Geology, Faculty of Science, Ghent University, Belgium;
[2] Departamento de Química Ambiental, Facultad de Ciencias, Universidad Católica de la Santísima Concepción, Chile;
[3] Centro de Investigación Dinámica de Ecosistemas Marinos de Altas Latitudes (IDEAL), Universidad Austral de Chile, Chile;
[4] Centro de Investigación Oceanográfica COPAS Sur-Austral, Departamento de Oceanográfia, Universidad de Concepción, Chile.

Research objective

Patagonian fjord sediments are increasingly used as high-resolution archives of past climate and environmental change, including variations in glacier mass balance, flood frequency, and seismic activity. To accurately interpret these proxy records, it is crucial to comprehend modern day sedimentation processes and determine sediment provenance. With this in mind, the main objective of this study is to identify inexpensive parameters that can be used to reconstruct sediment provenance in the fjords of Chilean Patagonia.

Setting



We focus on the Baker-Martínez fjord system, which is located between the Northern (NPI) and Southern Patagonian Icefields (SPI) and seems particularly sensitive to climate change. This fjord system connects the terrestrial ecosystems of Patagonia with the SE Pacific Ocean, and most of its sediment originates from glacier-fed rivers draining either the Patagonian Batholith (PB; Baker and Huemules rivers) to the north (Herve et al, 2007; Pankhurst et al, 1999), or the Eastern Andes Metamorphic Complex (EAMC; Bravo and Pascua rivers) to the south (Augustsson et al, 2003; Faúndez et al, 2002).

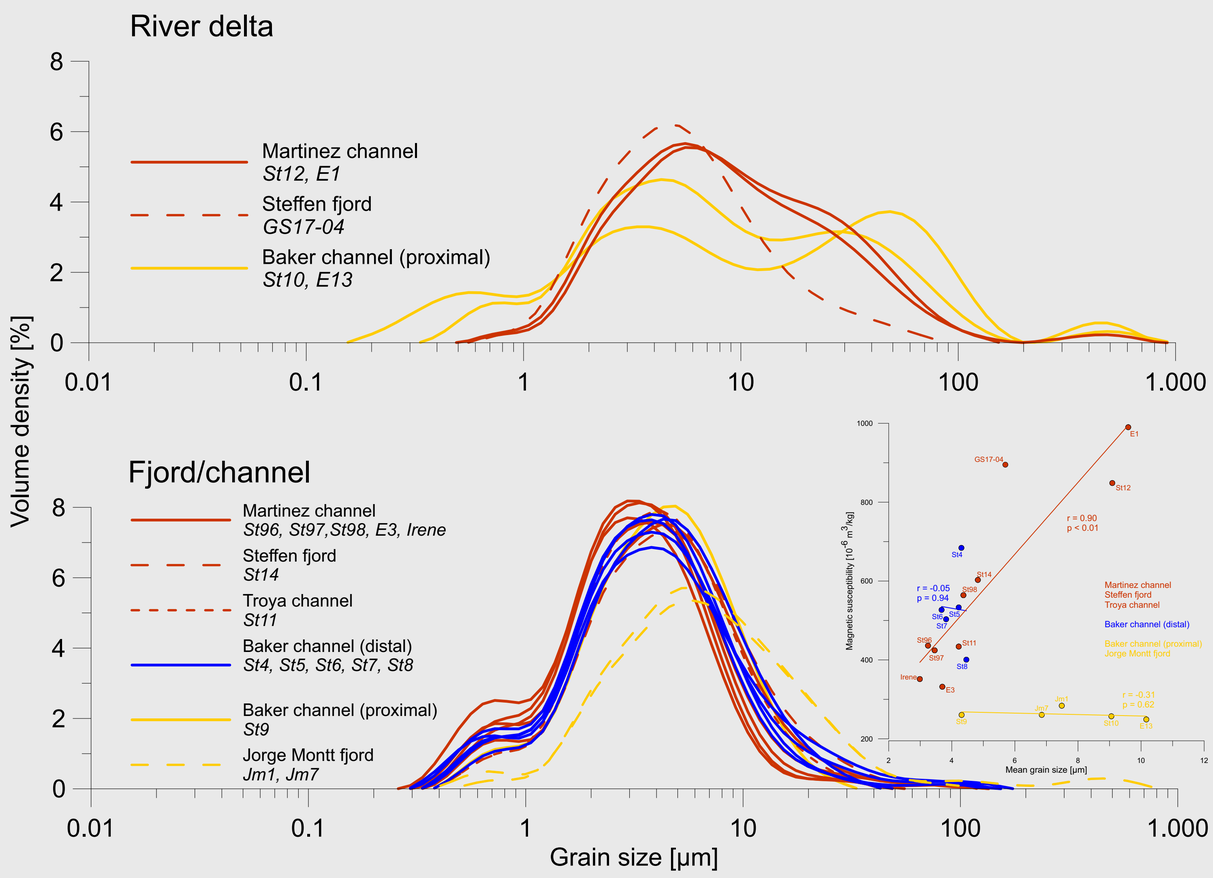
Methods

The composition of 22 surface sediment samples taken along the Baker-Martínez fjord system was investigated. In addition, suspended sediment samples collected at the mouths of the four main rivers that discharge into the fjord system were analyzed to define end-members. We focus on mass-specific magnetic susceptibility (MS) and inorganic geochemistry (ICP-AES; Fe and Ti), which seem to be particularly promising in this fjord system dominated by lithogenic sediments (85–97 wt%) (Rebolledo et al, 2019). In addition, we analyzed grain size using a Malvern Mastersizer 3000 to determine its influence on the above-mentioned parameters.

Grain size influence

Near the river deltas, grain size distribution is bimodal, i.e., fine silt and very fine sand. Away from the rivers, fjord sediments are dominated by fine silt.

Grain size and MS are significantly correlated in Martínez channel, however, this correlation is absent in Baker channel.

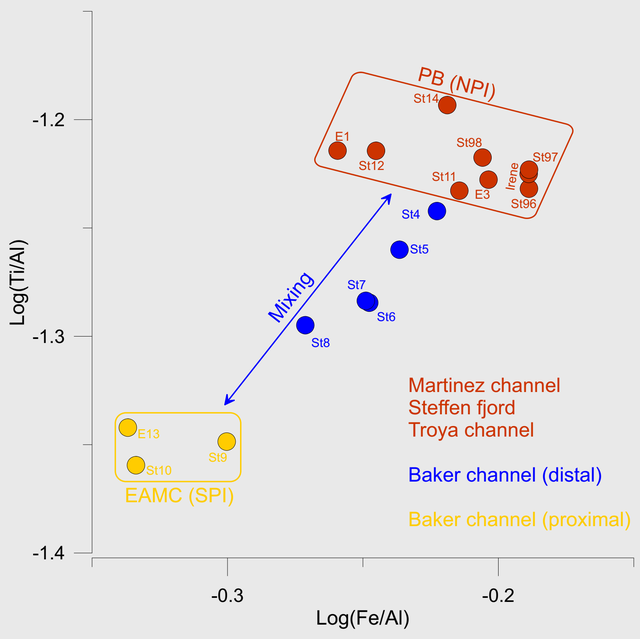


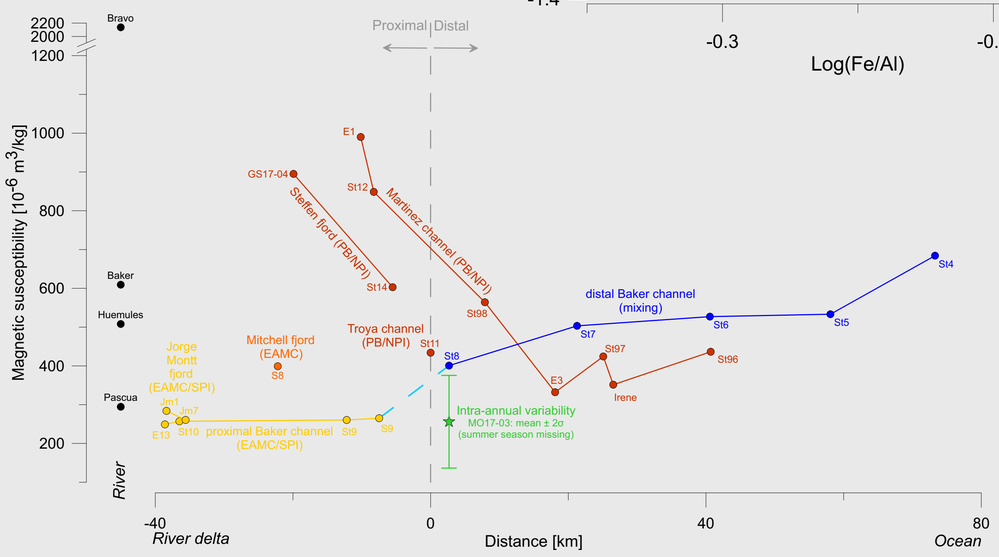
Magnetic susceptibility and inorganic geochemistry

Our results indicate that sediments derived from the PB are characterized by high MS, Ti/Al, and Fe/Al values, reflecting the granodioritic nature of the batholith (rich in pyroxene and amphibole). In contrast, sediments from the southern EAMC-derived Pascua river have significantly lower MS, Ti/Al, and Fe/Al values.

Martínez channel and the proximal part of Baker channel each receive sediment from only one source, i.e., the PB and the EAMC, respectively.

In the distal part of Baker channel, sediments from both sources mix with increasing contribution from batholith sediments towards the Gulf of Penas.





Conclusions

- In Martínez channel, MS is controlled by grain size, however, this control is absent in Baker channel. In the distal part of Baker channel, where PB- and EAMC- derived sediments mix, MS is controlled by provenance.
- This study suggests that MS and inorganic geochemistry (Ti/Al and Fe/Al) can be used to reconstruct sediment provenance within the Baker-Martínez fjord system.
- Ultimately, applying these provenance indicators to long sediment cores from the same fjord system will allow us to reconstruct relative variations in the behavior of outlet glaciers from both icefields independently.

References

Augustsson et al. (2003). Geological Society, London, Special Publications, 208(1), 253-268.
Eomap (2019). IIWQ World Water Quality Portal (UNESCO).
Faúndez et al. (2002). New Zealand Journal of Geology and Geophysics, 45(4), 411-425.
Herve et al. (2007). Lithos, 97(3-4), 373-394.
Pankhurst et al. (1999). Journal of the Geological Society, 156(4), 673-694.
Rebolledo et al. (2019). Progress in Oceanography, 174, 89-104.
Segemar (2003). Mapa geológico de la Provincia de Santa Cruz, Republica Argentina.
Sernageomin (2003). Mapa geológico de Chile version digital.

Contact
Matthias.Troch@UGent.be
www.rcmg.ugent.be